



CERTIFICATE

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Document Name: CGA C-11: Recommended Practice for Inspection of Compressed Gas Cylinders at Time of Manufacture

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RECOMMENDED
PRACTICES FOR
INSPECTION OF
COMPRESSED GAS
CYLINDERS AT TIME
OF MANUFACTURE
THIRD EDITION

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Docket 98-22
Cylinder Specifications Committee

NOTE—Technical changes from the previous edition are underlined.

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Contents	Page
1 Introduction	1
1.1 Purpose	1
1.2 Scope	1
1.3 General	1
2 Definitions	1
2.1 Certifying inspector	1
2.2 Chemical analysis	1
2.3 Heat, cast, or inspection lot number	2
2.4 Independent inspection agency	2
2.5 Inspection	2
2.6 Inspector of the manufacturer	2
2.7 Lot	2
2.8 Test	2
2.9 Verify	2
2.10 Witness	2
3 Qualifications of the certifying inspector	2
4 Inspection requirements—seamless cylinders	3
4.1 Duties of certifying inspector	3
4.2 Inspection practices	3
5 Inspection requirements—welded and brazed cylinders	6
5.1 Duties of certifying inspector	6
5.2 Inspection practices	7
6 Inspection requirements—nonrefillable cylinders	10
6.1 Duties of certifying inspector	10
6.2 Inspection practices	11
7 References	12
Appendices	
Appendix A—Certificate of compliance and test report—seamless cylinders	13
Appendix B—Certificate of compliance and test report—welded or brazed cylinders	14
Appendix C—Certificate of compliance and test report—completed acetylene cylinders	15
Appendix D—Record of chemical analysis of material for cylinders	16
Appendix E—Record of physical test of material for cylinders	17
Appendix F—Record of hydrostatic tests of cylinders	18
Appendix G—Record of hydrostatic tests of cylinders (sample basis)	19
Appendix H—Inspection report covering the manufacture of specification DOT 39 cylinders or spheres	20

CGA C-11-2001

CGA C-11-2001

1 Introduction

1.1 Purpose

The purpose of this publication is to promote safety by outlining inspection requirements of U.S. Department of Transportation (DOT), Title 49 *Code of Federal Regulations* and the Canadian standard CAN/CSA B339, *Cylinders, Spheres and Tubes for the Transportation of Dangerous Goods*, as called for by the *Transportation of Dangerous Goods Regulations* of Transport Canada (TC) for cylinders as interpreted and practiced by manufacturers and inspectors [1, 2, 3].¹

1.2 Scope

This publication is applicable to all cylinders, tubes, and spheres, hereafter referred to as "cylinders," and to inspection by either an approved independent inspection agency or inspectors of the manufacturer.

1.3 General

Tests and inspection procedures are necessary to ensure compliance with applicable specifications. However, specifications and inspection procedures are distinctly different and must be separated. A product specification is legislative while inspection procedures are judicial.

Acceptance and certification of product to a given specification will usually be in batch or lot size quantities and may be based on testing or inspection frequencies from 100% of product for some attributes to one item per lot for other attributes. Between these extremes, intermediate frequencies of examination are appropriate when sufficient to allow the inspector to certify acceptance of a lot to a given specification. Frequency of specific inspections or tests shall in no case be less than required by applicable specifications.

Aside from frequency of testing, the method of arriving at decisions concerning compliance is vital. One important distinction is the difference between witnessing and verifying. Witnessing implies a physical presence, whereas verifying will usually involve gaining information without physical presence by examining records or statements of other persons in whom trust has been placed.

For DOT regulations, either witnessing or verifying can be delegated by the certifying inspector, but he retains responsibility for the decision. Where an independent inspection agency is required by specification, the delegation of witnessing and verification is limited to an agency employee.

For Canadian regulations, the inspections must be performed by the staff of the inspector as described in the application for registration.

Calibration of all testing equipment must be performed by qualified persons to ensure accuracy.

2 Definitions

Many words and phrases are used repeatedly in DOT and/or TC specifications. The most widely accepted definitions for some of the more common terms are outlined in this section.

2.1 Certifying inspector

Any individual with the authority to sign and submit reports as required by DOT or TC regulations.

NOTE—In this document, certifying inspector and inspector are used interchangeably. (For qualifications, see Section 3.)

2.2 Chemical analysis

An ascertainment of the kind and amount of the elements constituting a material. The analysis must determine at least those elements prescribed for the material grade.

¹References are shown by bracketed numbers and are listed in order of appearance in the reference section.

2.3 Heat, cast, or inspection lot number²

Material defined and identified by the producer thereof as originating either from one melting cycle in a furnace or from several melting cycles so conducted as to render a cast product essentially identical with respect to its inherent characteristics.

2.4 Independent inspection agency

For DOT regulations an organization approved in writing by the Director of the Office of Hazardous Materials Operations. For TC regulations, an independent inspector (third party) is an organization holding a Certificate of Registration from TC. In either case, the organization shall not manufacture cylinders nor be directly or indirectly controlled by a cylinder manufacturer (formerly "disinterested" inspector).

2.5 Inspection

An act of viewing, measuring, or examining closely and critically, using appropriate aids as needed.

2.6 Inspector of the manufacturer

A competent individual employed by the cylinder manufacturer and designated as his certifying inspector (formerly "interested" inspector). For TC regulations, employees of the manufacturer shall not be permitted to act as the certifying inspector.

2.7 Lot

A quantity of cylinders having the same size, design, construction, material grade, and heat treatment (when applicable), which are designated by the manufacturer for approval through sample testing as defined by the applicable regulations.

2.8 Test

A particular procedure or method used to measure or assess the physical characteristics of a cylinder.

2.9 Verify

To confirm either by examination, evidence, testimony, research, demonstration, or comparison.

2.10 Witness

To see or know by personal presence or personal observation.

3 Qualifications of the certifying inspector

The certifying inspector shall:

- have at least 5 years experience in cylinder manufacturing operations or related industries or a college engineering degree plus one year of such experience;
- have a full understanding of the applicable DOT and/or TC cylinder specifications;
- have a full understanding of any other specifications or regulations required by reference in the applicable DOT and/or TC cylinder specifications;
- have a thorough understanding of the cylinder manufacturing process and quality control procedures;
- have a thorough understanding of all specified tests, test apparatus, test procedures, inspection techniques, and equipment as they relate to the applicable cylinder specifications;
- be capable of reading and writing English to achieve a full understanding of these requirements and associated documents; and
- be capable of directing those persons subordinate to him so that results of tests and inspections are coordinated into an accurate and reliable report of each cylinder lot produced.

² The steel industry uses a heat number to identify a single melt in a particular furnace, and the ingots cast from that melt are identified by the heat number. The aluminum industry uses a cast or melt number in similar fashion and this identity accompanies cast ingots. In addition, the aluminum producers supply extruded billets that are identified by an inspection lot number. The billet lot may originate as several different melts of the same alloy that was stored in ingot form under a "bonded stock" system.

In addition to the previous, the certifying inspector shall have knowledge of the following:

- concepts of containment of compressed gases in cylinders;
- cylinder material properties;
- wall stress/sidewall thickness relationship;
- volumetric expansion test and interpretation of results;
- metal working effects; and
- heat treatment/physical property relationships.

Documentation shall exist to verify that the certifying inspector has demonstrated satisfactory knowledge of the above qualifications.

Every inspector of the manufacturer or any other person performing work that will be verified by the certifying inspector shall have their training to perform such functions documented.

4 Inspection requirements—seamless cylinders

Seamless cylinders are those having integrally formed heads and bottoms with no welding allowed except as authorized by the individual specification under which these cylinders are manufactured. With few exceptions, seamless cylinders require inspection by an independent inspection agency.

4.1 Duties of certifying inspector

The certifying inspector must ensure that the following duties are performed in accordance with the individual DOT/TC specification under which the cylinders are being manufactured:

- determine that materials are in compliance with the requirements of the specification;
- verify that material was properly identified;
- perform internal inspection before closing;
- perform, witness, or verify external inspection;
- verify that the minimum design sidewall thickness and the end thickness requirements (when specified) were met by measurement or by witnessing measurement;
- verify proper heat treatment;
- select or approve the selection of all samples to be tested;
- witness hydrostatic test, burst test, tensile test, flattening test, and leakage test as required by the specification;
- verify cycle test, hardness test, magnetic particle inspection, or other nondestructive tests for flaws;
- verify threads by gauge;
- verify proper markings; and
- prepare the required report.

4.2 Inspection practices

4.2.1 Material

The use of specified material shall be verified by the inspector by examination of documentation furnished by the material supplier.

Each certified chemical analysis shall be checked against the limits set forth for the grade. In the absence of a certified analysis, a check analysis of samples taken from each heat is acceptable to verify compliance with requirements. In the absence of heat identity, each starter unit (such as individual coil, sheet, plate billet, tube, etc.) must be analyzed.

A heat code representing this heat shall be accurately associated with each cylinder (or production lot if allowed by specification) at a suitable point during manufacture. Traceability of starting material shall be made by any efficient and reliable method. Appropriate permanent marking in nonstressed or low stress areas of the cylinder is allowed, and may be mandated by individual specifications.

Material used for attachments to cylinders by welding, where permitted, shall be verified as to weldability and compliance with the specification concerned.

4.2.2 Shells

Each shell, regardless of the process by which it is made, shall be given a complete internal and external visual inspection for defects. Internal inspection must be accomplished before ends are closed. Criteria for rejection shall be as defined in the applicable DOT/TC specification.

Thickness of cylindrical walls and heads shall be verified to be not less than the minimum specified. X-rays or beta rays for measuring or ultrasonic means of thickness gauging are acceptable.

Irregularities in shape of heads or cylindrical portions of shells should be noted and rejected if determined to be injurious to the finished cylinder.

Removal of metal from the cylinder walls or heads is permitted provided such shells are reinspected and measured for compliance with the minimum thickness specified.

The closing-in (or necking) should be monitored as needed for any evidence of material defects not previously observed in the shell ends, and for uniformity in shape of the closed end and neck.

Special critical observation shall be made of shells for DOT 3HT and TC-3HTM cylinders because of extra high stress design. Magnetic particle inspection shall be witnessed or verified.

4.2.3 Heat treatment

The inspector shall verify that cylinders have been heat treated in accordance with the specification for the cylinder being manufactured by periodic observation of the equipment, instrumentation, and charts.

The inspector shall be responsible to see that the method of selecting and preparing sample specimens from heat treatment lots for physical tests is proper.

After heat treatment, any nondestructive inspection shall be verified if required by the TC/DOT specification.

4.2.4 Hydrostatic test

The inspector shall be responsible to see that the internal pressure testing of each cylinder is as prescribed by the specification. See CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders* [4].

Where hydrostatic expansion measurement is required, the test shall be witnessed by the inspector. As a minimum, total expansion and permanent expansion shall be recorded.

Where proof testing only is performed, the tests shall be witnessed by the inspector.

Any cylinder not complying with the acceptance criteria shall be rejected, subject to possible rework or retest as authorized by the specification.

4.2.5 Leakage test

Where cylinder ends are closed by the spinning process, or subsequently plugged, each cylinder shall receive the leakage test prescribed by cylinder specifications. The inspector shall witness all tests.

4.2.6 Tensile test

Tensile testing of the specimens shall be witnessed by the inspector as required by DOT and/or TC specifications.

Test results shall be confirmed by examination of the data including specimen dimensions and calculations. Results shall be compared with acceptability criteria for the particular cylinder design.

When the test results do not meet the requirements specified, the cylinder lot shall be rejected subject to re-heat-treatment or retest as authorized by the specification.

A retest is authorized if an improper test was made due to the presence of a flaw in the specimen or if the equipment or procedure was faulty.

4.2.7 Flattening test

The inspector shall witness the flattening test of a representative sample from each production lot.

Flattening tool surfaces shall be verified for dimensional conformance.

Acceptable degree of flattening shall be based on the actual measured average thickness of the test sample and shall be verified by the inspector.

Results shall be compared with acceptability criteria for the particular cylinder design. When the test results do not meet the requirements specified, the cylinder lot shall be rejected subject to reheat-treatment or retest as authorized by the specification.

A retest is authorized if an improper test was made due to the presence of a flaw in the specimen or if the equipment or procedure was faulty.

4.2.8 Bottom dimension measurement

The bottoms of cylinders shall be sampled periodically to determine conformance with design thickness and shape. Cylinders destroyed for physical and flattening tests may be used for this inspection.

4.2.9 Burst tests

Burst tests, performed on samples selected in accordance with the applicable specification, shall be witnessed by the inspector (Example: DOT 3HT, 3E, TC-3HTM, 3EM).

Results shall be compared with acceptability criteria for the particular cylinder design. When the test results do not meet the requirements specified, the cylinder lot shall be rejected subject to reheat-treatment or retest as authorized by the specification.

A retest is authorized if an improper test was made due to the presence of a flaw in the specimen or if the equipment or procedure was faulty.

Location and type of failure shall be noted for substantiation of proper design and fabrication.

4.2.10 Cycle tests

Pressure cycling tests, performed on samples selected in accordance with the applicable specification, shall be verified by the inspector.

Rate of cycling, pressure, and effect on the cylinder shall be verified for conformance with the requirements of the specification. When the test results do not meet the requirements specified, the cylinder lot shall be rejected. If the cause of failure is found to be improper heat treatment, reheat-treatment is authorized.

A retest is authorized if an improper test was made due to faulty equipment or procedure.

Cycle test cylinders may be used for burst test after passing the test, but shall then be destroyed in all cases.

4.2.11 Threaded openings

Threaded openings in each cylinder shall be inspected and gauged for compliance with the design specification as well as quality.

Performance of this inspection shall be verified by the inspector.

4.2.12 Cylinder markings

Cylinders shall be checked for compliance with DOT and/or TC marking requirements.

The inspector shall verify that all official marks have been applied to finished cylinders and are legible, adequate in depth and size, in a permissible location, and in proper sequence.

Where marking of elastic expansion (E.E. or R.E.E.) is required, as for DOT 3HT or TC-3HTM cylinders, the inspector shall verify that an adequate system is used to ensure proper and accurate application.

4.2.13 Weld or braze inspection

Where specifications permit and welding or brazing of a necking or a footing has been performed, the inspector shall verify weld method acceptability and shall visually inspect for suitable quality. Standards for DOT or TC welded cylinders shall be used where applicable.

4.2.14 Report

The certifying inspector shall assemble and review all data necessary to prepare the complete report.

Test results, chemical analyses, wall thicknesses and other support data needed shall be reviewed and authenticated as in compliance with regulations.

The data shall be used for preparation of applicable Appendices A through G in clear and legible form. The format of this report may be modified by individual inspectors to reflect particular manufacturing conditions, but all information shown must be incorporated or attached. In the case of TC-3FCM and TC-3HWM cylinders, the appropriate forms provided in CAN/CSA B339 and identified in the particular specification must be used [2].

The certifying inspector shall render the complete report to the cylinder manufacturer and upon request to the cylinder purchaser. Reports shall be kept on file by the inspector and manufacturer as required by the specification.

5 Inspection requirements—welded and brazed cylinders

The DOT permits most welded or brazed cylinder specifications (DOT series 4 and 8) to be inspected by an inspector of the manufacturer, provided that manufacturer is based in the United States.

NOTE— It is mandatory that all cylinders manufactured for use in Canada have independent (third party) inspections.

5.1 Duties of certifying inspector

The certifying inspector must ensure that the following duties are performed in accordance with individual DOT/TC specification under which the cylinders are being manufactured:

- determine that materials are in compliance with the requirements of the specifications;

- verify that material was properly identified;
- verify that visual inspection, including that of the welds, is performed;
- verify that minimum design thickness for the sidewall and heads were met;
- verify that welding operators and processes are qualified in accordance with CGA C-3, *Standards for Welding on Thin-Walled Steel Containers* requirements (where specified) [5];
- verify porous filler tests, where applicable;
- verify proper heat treatment;
- select or approve the selection of all samples to be tested;
- witness volumetric expansion tests, burst tests, flattening tests, impact tests, and tensile tests (as required by the specification);
- witness or verify proof tests;
- verify cycle tests, heat transfers tests, and any specified nondestructive tests and/or examinations (as required by the specification);
- ensure acceptable weld quality by witnessing of tests of welds and examination of radiography as specified;
- verify threads by gauge;
- verify proper markings; and
- prepare the required report.

5.2 Inspection practices

5.2.1 Material

The use of specified material shall be verified by the inspector by examination of documentation furnished by the material supplier.

In the case of material for the body of the cylinder (that is, shells, body section, or heads), each certified chemical analysis shall be checked against the limits set forth for the grade.

In the absence of a certified analysis, a check analysis of samples taken from each heat is acceptable to verify compliance with requirements. In the absence of heat identity, each starter unit (such as individual coil, sheet, plate, tube, etc.) must be analyzed.

The inspector shall verify that the system of identification of material used through the fabrication of cylinders is capable of identifying the specified material grade with production lots of cylinders.

Material used for attachments to cylinders by welding shall be verified as weldable and in compliance with the applicable DOT/TC specification.

5.2.2 Inspection of subassemblies

The inspector shall verify that drawn shells or formed heads are given a complete visual inspection for material defects before the welding or brazing operation.

Thickness of cylindrical walls and heads shall be verified to be not less than the minimum specified.

Dimensions of parts shall be verified to ensure that:

- diameter, length, and shape meet design specifications; and
- mating edges are accurate for the welded or brazed joint intended.

The inspector shall verify that subassemblies that have a welded or brazed longitudinal seam are visually inspected on the inside and outside for material and joint defects. It shall be verified that:

- radiographic inspection is performed to the extent called for by the specification (Example: DOT 4BW, DOT 4L, TC-4BWM, TC-4LM);
- longitudinally welded joints are visually inspected for complete penetration; and
- brazed joints are examined for conformance with the width of the lap and completeness of brazing penetration along the entire seam.

Attachments shall be verified to meet design specifications.

5.2.3 Inspection of assembled product

All completely assembled cylinders shall be visually examined externally for weld or braze quality.

Where visual inspection must be amplified due to questionable features of a weld or special service requirements for a cylinder, other nondestructive tools that may be used are:

- penetrants;
- magnetic particle inspection;
- radiography (requirement of DOT 4DS, 4DA, TC-4DSM, TC-4DAM); or
- pressure testing.

Samples of completed assemblies from each production run should be given a complete dimensional check including measurement of internal volume.

5.2.4 Porous filler tests

Each completed acetylene cylinder (DOT 8, DOT 8AL, TC-8WM, TC-8WAM) shall have the clearance between the porous filler and the cylinder measured to determine compliance with the applicable specification.

Porosity of porous filler from representative cylinders shall be determined as required by the specification for compliance with the specification limits.

5.2.5 Heat treatment

The inspector shall verify that cylinders or formed parts have been heat treated in accordance with the specification for the cylinder being manufactured by periodic observation of the equipment, instrumentation, and charts.

The inspector shall confirm that heat treatment follow all welding operations (DOT 4BA, 8AL, 4AA, 4AA480, 4BW, 4DA, 4D; TC-4BAM, 8WAM, 4AAM, 4BWM, 4DAM, 4DM) where cylinder specifications require it.

The inspector shall be responsible for the method of selecting and preparing sample specimens from heat treatment lots for physical tests.

5.2.6 Hydrostatic tests

The inspector shall be responsible for ensuring the internal pressure testing of each cylinder as prescribed by the specification.

Where hydrostatic expansion measurement is required, the test shall be witnessed by the inspector. As a minimum, total expansion and permanent expansion shall be recorded.

For DOT 4L/TC-4LM, where proof testing only is performed, the tests shall be witnessed by the inspector. All other proof tests shall be verified.

Any cylinder not complying with the acceptance criteria shall be rejected by the inspector, subject to possible rework or retest as authorized by the specification.

5.2.7 Tensile tests

Tensile testing of specimens as called for by DOT/TC specification shall be witnessed by the inspector. The inspector shall confirm the test results by examination of the data including specimen dimensions and calculations.

Results shall be compared with acceptability criteria for the particular cylinder design. When the test results do not meet the requirements specified, the cylinder lot shall be rejected subject to reheat treatment or retest as authorized by the specification.

A retest is authorized if an improper test was made due to the presence of a flaw in the specimen or if the equipment or procedure was faulty.

5.2.8 Welds—test and examination

Physical tests and radiographic examination of welds when required shall be made in accordance with the applicable specification and meet the requirements of CGA C-3 [5]. Tests of welds shall be witnessed by the inspector.

Tensile test results shall be confirmed by examination of data including specimen dimensions, location of break, and calculations. Results shall be compared with acceptability criteria for the particular cylinder design.

Bend tests of the weld shall be inspected after bend for ductility, indication of lack of penetration, and proper size bending radius.

Radiographic results shall be confirmed by examination of permanent film records or by witnessing fluoroscope results.

Should any results fail to meet requirements, the production lots in question shall be rejected subject to any authorized additional examination or rework and retest.

5.2.9 End dimension measurement

The ends (heads, bottoms) of cylinders destroyed for physical tests should be inspected to determine conformance with design thickness and shape.

5.2.10 Other tests

Flattening tests, where specified, (DOT 4DA, 4E, 4D; TC-4DAM, 4EM, 4DM) shall be in accordance with 4.2.7.

Burst tests, where specified, (DOT 4BW, 4DS, 4E; TC-4BWM, 4DSM, 4EM) shall be in accordance with 4.2.9.

Impact tests, where required, shall be witnessed by the inspector (Example: DOT 4L, TC-4LM). Tests shall be performed at the marked service temperature of the finished cylinder (DOT 4L, TC-4LM) or at the temperature required by the applicable specification. Specimens shall be closely checked for dimensional compliance.

Where a specification sets forth limits of heat transfer for the cylinder construction (Example: DOT 4L, TC-4LM), the inspector shall verify that the specification is being met by appropriate heat transfer tests. Data should be recorded and filed.

Cycle tests, where specified, shall be in accordance with 4.2.10.

5.2.11 Threaded openings

Threaded openings in cylinders shall be verified as to compliance with the product specification as well as quality.

Threaded openings in completed cylinders shall be inspected and gauged on a frequency sufficient to assure the inspector that the specification requirements are being met.

5.2.12 Cylinder markings

Cylinders shall be checked for compliance with DOT and/or TC marking requirements.

The inspector shall verify that all official marks have been applied to finished cylinders and are legible, adequate in depth and size, in a permissible location, and in proper sequence.

5.2.13 Report

The certifying inspector shall assemble and review all data necessary to prepare the complete report.

Test results, chemical analyses, wall thicknesses and other measurements, lot identification records, and other support data needed shall be required and authenticated in compliance with regulations.

The data shall be used for preparation of applicable Appendices A through G in clear and legible form. The format of this report may be modified by individual inspectors to reflect particular manufacturing conditions, but all information shown must be incorporated or attached.

The certifying inspector shall render a complete report to the cylinder manufacturer and, upon request, to the cylinder purchaser. Reports shall be kept on file by the inspector and manufacturer as required by the specification.

6 Inspection requirements—nonrefillable cylinders

Nonrefillable (disposable) cylinders are cylinders of welded, brazed, or seamless design not exceeding 55 lb (25 L) water capacity manufactured to DOT specification 39 or TC-39M. For DOT regulations, inspection by an inspector of the manufacturer is authorized for service pressures not exceeding 900 psig (6210 kPa)³. Nonrefillable cylinders with service pressures greater than 900 psig (6210 kPa) require inspection by an independent inspection agency.

NOTE—For TC regulations, all cylinders must have independent inspection.

6.1 Duties of certifying inspector

The certifying inspector must ensure that the following duties are performed in accordance with the DOT 39 and/or TC-39M specification:

- determine that materials are in compliance with the requirements of the specification;
- verify that the material was properly identified;
- verify that visual inspection, including that of the welds, is performed;
- verify that minimum design wall and end thickness requirements were met;
- verify that the welding operator and process used qualify in accordance with CGA C-3 [5];
- verify proper heat treatment, if applicable;
- select or approve the selection of all samples to be tested;
- witness hydrostatic burst test and flattening test;
- witness or verify all pressure tests;
- ensure acceptable welded or brazed joints by verification of joint examination;

³ kPa shall indicate gauge pressure unless otherwise noted as (kPa, abs) for absolute pressure and (kPa, differential) for differential pressure. All kPa values are rounded off per CGA P-11, *Metric Practice Guide for the Compressed Gas Industry* [6].

- verify openings and/or threads by gauge;
- verify proper markings; and
- prepare and retain required reports.

6.2 Inspection practices

6.2.1 Material

The use of specified material shall be verified by examination of documentation furnished by the material supplier.

In the case of material for the body of the cylinder (that is, shells, body section or heads), each certified chemical analysis provided by the material manufacturer for each heat of material (ladle analysis is acceptable) must be checked against the limits set forth by the specification.

In the absence of a certified analysis, a check analysis of samples taken from each heat is acceptable to verify compliance with requirements. In the absence of a heat identity, a check analysis of samples taken from each sheet, coil, or tube is acceptable.

Material used for attachments to cylinders by welding or brazing shall be verified as suitable for the process.

6.2.2 Inspection of subassemblies

The inspectors shall verify for cylinders with service pressure of 500 psig (3450 kPa) or less that the manufacturing process for drawn shells or formed heads is fully capable of producing parts free of defects. For cylinders with service pressure in excess of 500 psig (3450 kPa), each shell or drawn head shall be visually inspected internally and externally for defects before welding or brazing operations.

Thickness of cylinder walls and heads shall be verified to meet the minimum design thickness requirements.

Dimensions of parts shall be verified to ensure that:

- diameter, length, and shape meet design specifications; and
- mating edges are accurate for the welded or brazed joint intended.

The inspector shall verify that subassemblies having welded or brazed joints are visually inspected for material or joint defects.

Attachments shall be verified to meet design specification.

Closing-in (or necking) in seamless cylinders shall be verified as to producing uniformity in shape of closed end or neck with no evidence of defect.

6.2.3 Inspection of assembled product

The inspector shall verify that assembled cylinders are externally examined for weld or braze quality either visually or by other suitable method.

The inspector shall verify that approved safety devices are properly installed when they are an integral part of the cylinder.

Samples of completed assemblies from each production run should be verified for dimensional compliance to design specification.

6.2.4 Heat treatment (if applicable)

The inspector shall verify that cylinders or formed parts have been heat treated in accordance with requirements.

6.2.5 Hydrostatic burst tests, proof tests, flattening tests, and leakage tests

Hydrostatic burst tests shall be witnessed by the inspector.

Proof tests shall be verified by the inspector.

Leakage tests shall be verified by the inspector.

The flattening test shall be witnessed by the inspector. Measurement of the degree of flattening shall be based on actual measured average thickness. Flattening tool surfaces shall be verified for dimensional conformance.

Any cylinder not complying with the acceptance criteria shall be rejected subject to possible rework or retest as authorized by the specification.

A retest is authorized if an improper test was made due to faulty equipment or procedure.

6.2.6 Openings

Threaded openings in cylinders shall be verified for compliance with design specification.

Threaded openings in completed cylinders shall be inspected and gauged on a frequency sufficient to assure the inspector that the specification requirements are being met.

6.2.7 Cylinder markings

The inspector shall verify that cylinders are legibly marked in accordance with marking requirements.

6.2.8 Report

The certifying inspector shall assemble and review all data necessary to prepare the complete report.

Test results, chemical analyses, wall thicknesses and other measurements, lot identification records and other supporting data needed shall be reviewed and authenticated to be in compliance with regulations.

The report shall be clear and legible on the form specified in Appendix H. The format of this report may be modified by individual inspectors to reflect particular manufacturing conditions, but all information shown must be incorporated or attached. Reports shall be kept on file by the inspector and the manufacturer as required by the specification.

7 References

[1] *Code of Federal Regulations*, Title 49 CFR Parts 100-180 (Transportation), Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[2] CAN/CSA B339, *Cylinders, Spheres and Tubes for the Transportation of Dangerous Goods*, Canadian Standards Association, 178 Rexdale Blvd. Etobicoke, Ontario, Canada, M9W 1R3.

[3] *Transportation of Dangerous Goods Regulations*, CCG Publishing, Ordering Dept., Ottawa, Ontario, Canada, K1A 0S9.

[4] CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*, Compressed Gas Association, Inc., 4221 Walney Rd., 5th Floor, Chantilly, VA 20151.

[5] CGA C-3, *Standards for Welding on Thin-Walled Steel Containers*, Compressed Gas Association, Inc., 4221 Walney Rd., 5th Floor, Chantilly, VA 20151.

[6] CGA P-11, *Metric Practice Guide for the Compressed Gas Industry*, Compressed Gas Association, Inc., 4221 Walney Rd., 5th Floor, Chantilly, VA 20151.

Appendix A—Certificate of compliance and test report—seamless cylinders
Manufactured under Dept. of Transportation regulations

Manufacturer: _____

Location: _____

CYLINDER DESCRIPTION AND DESIGN CRITERIA:

DOT spec. _____

Service pressure: _____

Nominal size: _____ O.D. x _____ Long

Test pressure: _____

Nominal volumetric capacity: _____

Minimum wall: _____

Calculated stress @ T.P.: _____

MANUFACTURING PROCESS:

Construction: (Billet pierce, tube, plate, etc.) _____

MATERIAL AND HEAT TREATMENT: _____

REPORT DETAILS:

Quantity: _____

Test date: _____

Serial no. range: _____

Heat no. or code: _____

Identifying symbol: _____

Lot numbers: _____

MARKINGS: _____

Inspector's mark: _____

MANUFACTURED FOR: _____

CONIGNED TO: _____

I hereby certify that I have determined that cylinders described on this report comply with the requirements of
Dept. of Transportation specification _____

Remarks: _____

Signed: _____
Inspector

Location: _____

Date: _____

CGA C-11-2001

CGA C-11-2001

Appendix B—Certificate of compliance and test report—welded or brazed cylinders
Manufactured under Dept. of Transportation regulations

Manufacturer: _____

Location: _____

CYLINDER DESCRIPTION AND DESIGN CRITERIA:

DOT spec. _____ Service pressure: _____

Nominal size: _____ O.D. x _____ Long Test pressure: _____

Nominal volumetric capacity: _____ Minimum wall: _____

Tare weight range: _____ Calculated stress @ T.P.: _____

Joint efficiency: _____

MANUFACTURING PROCESS:

Construction: (Welded, brazed, type seams, etc.) _____

MATERIAL AND HEAT TREATMENT: _____

REPORT DETAILS:

Quantity: _____ Test date: _____

Serial no. range: _____ Heat no. or code: _____

Identifying symbol: _____ Lot numbers: _____

MARKINGS: _____ Inspector's mark: _____

MANUFACTURED FOR: _____

CONSIGNED TO: _____

I hereby certify that I have determined that cylinders described on this report comply with the requirements of Dept. of Transportation specification _____

Remarks: _____

Signed: _____
Inspector

Location: _____

Date: _____

00000-11-11

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Appendix C—Certificate of compliance and test report—completed acetylene cylinders
Manufactured under Dept. of Transportation regulations

Manufacturer of completed cylinder: _____

Location: _____

Shell manufacturer: _____

Location: _____ Lot numbers(s); _____

CYLINDER DESCRIPTION AND DESIGN CRITERIA:

DOT spec. _____ Manufacturer's rated maximum capacity _____

Nominal size: _____ O.D. x _____ long Safety devices number & location _____

Manufacturer's design porosity range: : _____

MANUFACTURING PROCESS:

Type of filler. _____

REPORT DETAILS:

Quantity: _____ Test Date(s): _____

Serial no. range: _____ Tar weight range: _____

Identifying symbol: _____ Inspector's mark: _____

MARKINGS: _____

MANUFACTURED FOR: _____

CONIGNED TO: _____

A certified report of manufacture and test of the steel shells is attached hereto.

I hereby certify that I have determined that cylinders described on this report comply with the requirements of Dept. of Transportation specification _____

Remarks: _____

Signed: _____

Inspector

Location: _____

Date: _____

CGA C-11-2001

CGA C-11-2001

Appendix D—Record of chemical analysis of material for cylinders
(Typical form)

Serial no. range: _____ to _____ inclusive

Cylinder size: _____ O.D. x _____ long

Cylinder manufacturer: _____

Heat and code number.	Type of analysis (ladle, check)	Chemical analysis											
		C	P	S	Mn	Si	Cr	Mo	Cb	Cu	Ni	Al	Zr

Material manufacturer: _____

The above analyses have been verified to comply with material authorized by the specification. Chemical analyses were made by _____

Signed: _____
Inspector

Location: _____

Date: _____

Appendix E—Record of physical test of material for cylinders
(Typical form)

Serial no. range: _____ to _____ inclusive

Cylinder size: _____ O.D. x _____ long

Cylinder manufacturer: _____

Type of heat treatment: _____

Lot number	Yield strength psi	Tensile strength psi	Yield/tensile ratio*	Elongation % in _____ inchest†	Red in area %	Weld test * tensile bend	Flat test *	Burst test *	Cycle test *

* Where applicable

† Insert gage length of specimen

Signed: _____
Inspector

Location: _____

Date: _____

Appendix F—Record of hydrostatic tests of cylinders
(Typical form)

Serial no. range: _____ to _____ inclusive

Cylinder size: _____ O.D. x _____ long

Cylinder manufacturer: _____

Test method: _____

Test pressure: _____

Serial number of cylinders tested	Total expansion cm ³	Permanent expansion cm ³	Elastic expansion cm ³	Total weight without valve lb*	Volumetric capacity*

* Must be accurate to a tolerance of 1%

Signed: _____
Inspector

Location: _____

Date: _____

**Appendix G—Record of hydrostatic tests of cylinders (sample basis)
(Typical form)**

Serial no. range: _____ to _____ inclusive

Cylinder size: _____ O.D. x _____ long

Cylinder manufacturer: _____

Test method: _____

Test pressure: _____

Lot number	Lot size	Permanent expansion cm ³	Total expansion cm ³	% Ratio of permanent to total expansion

The above results represent sample cylinders selected from each lot. All other cylinders in the lot were subjected to a proof pressure of _____ psi and showed no defects.

Signed: _____
Inspector

Location: _____

Date: _____

Appendix H—Inspection report covering the manufacture of specification DOT 39 cylinders or spheres

The cylinders (spheres) covered by this report were manufactured for _____ located at _____. They were manufactured by _____ located at _____ whose Department of Transportation registration number is M_____. The cylinders are _____ inches in diameter (OD) and _____ inches in length. They have design test-pressure of _____ psig and a marked service pressure of _____ psig. Each has an internal volume of _____ cubic inches (nominal). These containers were made by process of _____

The metal used was identified by heat or analysis numbers as shown on the "Record of Chemical Analysis of Metal" attached hereto.

All materials and each cylinder was inspected. All accepted material was found free from seams, cracks, laminations, and other defects which might prove injurious to the strength of the cylinder. The processes of manufacture and heat treatment (if any) were observed and found satisfactory.

My record of tests and inspection for each lot covered by this report is as follows:

Lot number	Lot quantity	Lot test		All cylinders	
		Burst-pressure ¹	Flattening test ²	Pressure test ²	Visual inspection ²

¹ Enter the lowest actual failure pressure of all cylinders tested within the lot.

² Enter "Pass" or "Fail."

Inspector's name (print)

Inspector's signature

Date

Inspector's employer (company name)